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First measurements by the DTU Wind Energy short-range WindScanner

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Abstract

Introduction

Remote sensing Doppler Lidar instruments (Light detection and ranging) have been commercially available for wind resource assessment for quite some time now and they are measuring the radial wind component along their line of sights. The 3D wind vector is extracted from the line of sight wind speeds along several directions on a conical surface combined with the horizontal homogeneity assumption. However, over the large circular area scanned, this assumption is not applicable in complex terrain and around complex structures such as buildings and wind turbines.

Approach

At DTU Wind Energy, former Risø DTU, this is circumvented by the development of an alternative approach where the laser beams of three wind Lidars are directed synchronously towards a common movable location which gives the possibility to measure the full 3D wind vector field in a 3D geometry. Both a long-range WindScanner system based on WindCubes from Leosphere and a short-range WindScanner system based on modified ZephIRs from Natural Power are currently developed at DTU Wind Energy at the DTU Risø campus.

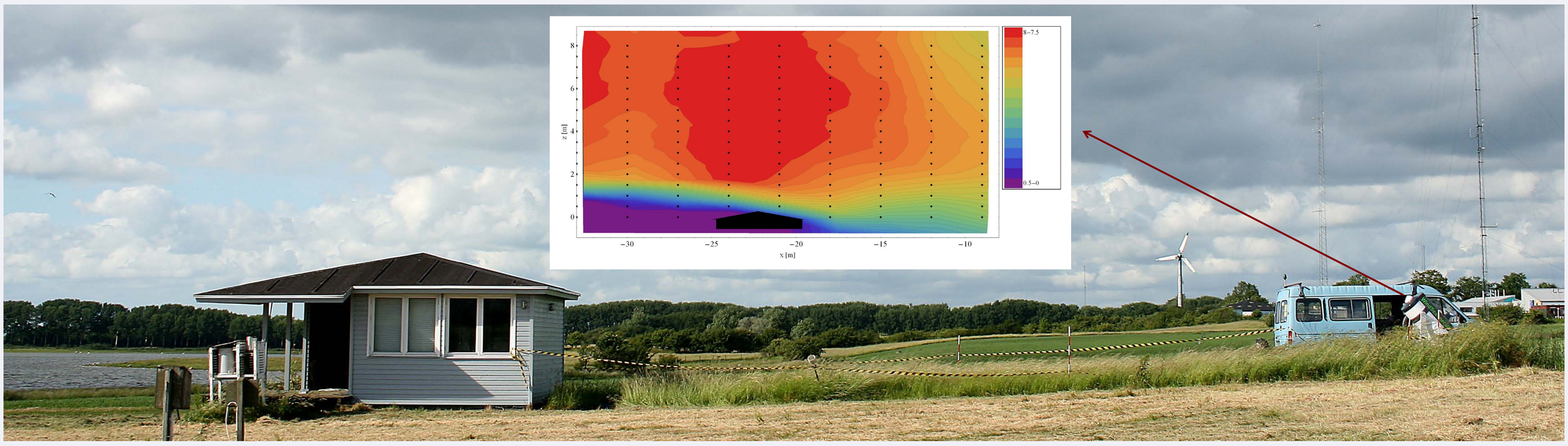
The short-range WindScanner

Here, the focus is on the continuous-wave short-range ZephIR-based WindScanner that rapidly can direct the wind Lidar laser beam by a double-prism arrangement in any direction within a cone with a full opening angle of 120 degrees and where the center of the measurement volume is accordingly changed by a dynamic focus mechanism. The Lidar can stream out averaged Doppler spectra at a rate of up to about 400 Hz and has been equipped with an acousto-optic modulator which allows for measurement of the sign of the radial wind speed, i.e., if the wind is directed away from or towards the Lidar.

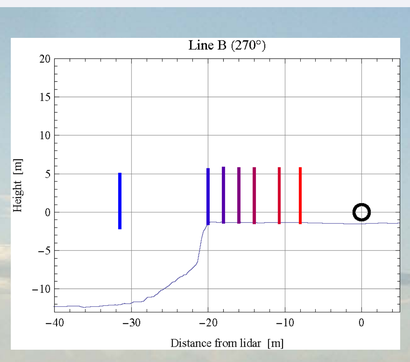
The first 2D measurements

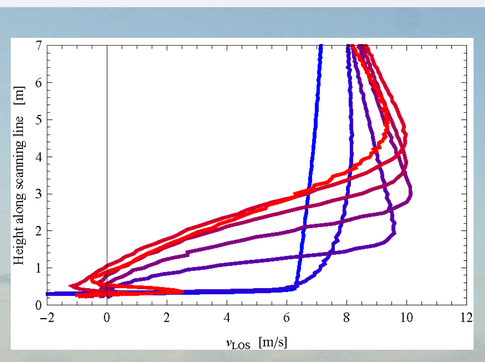
The first trials have included scanning in a vertical plane within the wake of a small building as well as within the flow that has passed a steep 12-m high escarpment at the small isolated Bolund peninsula in the Roskilde fjord in Denmark. Previously the flow over Bolund has been measured by classical instrumentation and used for comparison of various flow models since it is a good small-scale model site featuring flow phenomena that are typical for complex terrain in which wind turbines often are placed.

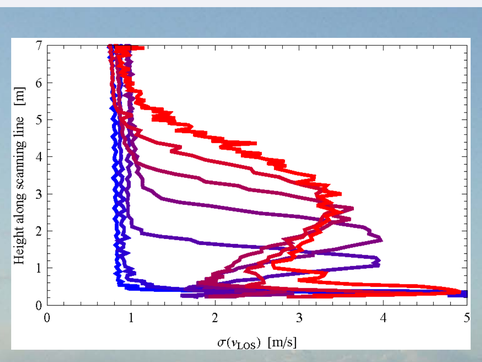
Rapid 2D scanning of the flow behind a building



Scanning of the flow above a steep 12-m high escarpment at the small isolated Bolund peninsula in the Roskilde fjord in Denmark







Conclusions

The short-range WindScanner system advances the possibilities of studying wind and turbulence fields in complex terrain, around wind turbines and buildings remotely without disturbing the flow by meteorological towers. This opens up many new research possibilities in the coming years. Here, the first 2D measurements of one wind vector component have been presented and the complete 3D measurements of all the 3 wind vector components are ongoing.

Acknowledgements

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